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MODEL IMPROVEMENT & STUDY MANAGEMENT AGENCY

DECEMBER 1990

ARMY STUDY HIGHLIGHTS

VOLUME XI

DEPUTY UNDER SECRETARY ARMY FOR OPERATIONS RESEARCH

DEPARTMENT OF THE ARMY
OFFICE OF THE UNDER SECRETARY
WASHINGTON, D.C. 20310-0102

20 December 1990

SAUS-OR

MEMORANDUM FOR SEE DISTRIBUTION LIST

SUBJECT: Army Study Highlights

The purpose of the *Army Study Highlights* is to acknowledge outstanding efforts of individual analysts and encourage continued excellence throughout the Army analysis community. This year Volume XI contains ten studies which provide an interesting mix. In this issue, we introduce an addition to the publication. We recognize the winners of the Wilbur B. Payne Memorial Awards for excellence in analysis for the best group-authored and individual-authored papers in Army systems analysis/operations analysis for 1990 in this volume.

The highlighted studies were professionally conducted and are of significance to the Army's missions and goals. Selection was based on assessment of the principal findings, main assumptions, principal limitations, scope, objectives and approach of each study. Examples of quality analysis have proven to be beneficial to the analysis community. I urge you to make the widest possible distribution of the *Army Study Highlights*, Volume XI.

I remind the analytic community of the importance of following the guidelines in our "call for nominations." This year, as in the past, some submissions were possible candidates for selection but were unusable because they were incomplete or otherwise confusing. It is not possible to request re-submissions because of time and review constraints; thus, potentially good papers are not reviewed. In the future, I urge that you use care in preparing your study gists and supporting information; they are very important to the selection process.

Thank you for your overwhelming response this year. It made for a very interesting, demanding, but worthwhile review.

We welcome your suggestions. They, as well as requests for additional copies of *Army Study Highlights*, should be directed to Ms. Gloria Brown, of US Army MISMA, (AV) 335-2952, (C) (202) 475-2952.

Walter W. Hollis
Deputy Under Secretary of the Army
(Operations Research)

SUBJECT: Army Study Highlights

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MODEL IMPROVEMENT & STUDY MANAGEMENT AGENCY

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STUDY GISTS

CAA	ARMORED SYSTEMS MODERNIZATION - MULTICORPS SUSTAINED OPERATIONS ANALYSIS (ASM-SUSOPS) (U)	STUDY SUMMARY CAA-SR-90-11

THE REASON FOR PERFORMING THE STUDY was to assess and compare both the combat capability and sustainability of three specified modernization alternatives in an extended multicorps campaign. This study was performed to support the Armywide Armored Systems Modernization (ASM) Milestone I acquisition decision process and was separate from the ASM Cost and Operational Effectiveness Analysis (ASM-COEA) performed by the US Army Training and Doctrine Command (TRADOC) Analysis Command (TRAC).

THE STUDY SPONSOR was the Technical Advisor to the Deputy Chief of Staff for Operations and Plans (DAMO-ZD).

THE STUDY OBJECTIVES were to:

(1) Assess and compare the combat capability and sustainability of the three modernization alternatives in a multicorps campaign, for an extended period, against a given threat.

(2) Identify trends in sustainability that result from varying levels of prepositioned war reserve stocks (PWRS).

(3) Assess the impact of potential Conventional Forces in Europe (CFE) agreements on the combat and sustainability of the mix alternatives.

THE SCOPE OF THE STUDY includes an examination of three specified modernization alternatives (Base Case (1996), Product Improved (PIP) (1999), and ASM (2004)) of heavy forces defending against the Warsaw Pact (WP) in Western Europe in 2004. SUSOPS narrows the typical Allied Forces, Central Europe (AFCENT) theater campaign to just the two forward-stationed US corps' (US V and VII Corps) slice of AFCENT and those WP forces arrayed against them. Three different scenarios, before Conventional Forces in Europe talks (Pre-CFE), CFE, and Post-CFE, with different levels of US and WP forces were examined. The Pre-CFE scenario is based on a modified version of TRAC-FLVN's Europe 6.9 scenario. The CFE scenario was based on the North Atlantic Treaty Organization (NATO) Proposal (negotiated parity). Post-CFE examines a fixed US force (QUICKSILVER) based on US budget cuts defending against six different threat levels.

THE MAIN ASSUMPTIONS of this work are:

(1) US Army multicorps force is at required strength. All combat units are at 100 percent of their authorized table of organization and equipment (TOE).

(2) Both opposing forces are fully modernized.

(3) Fuel, ammunition, repair parts, and personnel are unconstrained.

THE BASIC APPROACHES used in this study were to:

(1) Conduct a capability (combat and sustainability) assessment of the three modernization alternatives in a multicorps campaign. The Concepts Evaluation Model (CEM) was the analytical tool used to simulate the multicorps campaign(s).

(2) Conduct a comparative analysis of the three alternatives using measures of effectiveness (MOEs).

(3) Conduct a parametric analysis of varying levels of selected PWRS to identify trends on its impact on sustainability.

THE PRINCIPAL FINDINGS of the work reported herein are as follows:

(1) US force equipped with ASM has better warfighting capability resulting in retaining more terrain and providing the threat with the lowest probability of accomplishing threat objectives.

(2) Both PIP (1999 systems) and ASM (2004 systems) survivability and lethality are superior to the Base Case (1996 systems) alternative. ASM survivability and lethality are marginally superior to PIP.

(3) US force equipped with ASM provides most combat power over time and has greater capability to seize the initiative.

(4) Modernization of the US Army heavy force with the ASM family of systems provides additional insurance against threat uncertainty.

(5) ASM family of systems is better sustained over time relative to PIP and Base Case alternatives.

(6) US Army sustainability and warfighting capability are improved as the levels of PWRS are increased. In particular, increasing howitzer PWRS improves both tank and armored fighting vehicle sustainability.

THE STUDY EFFORT was directed throughout by MAJ Eric J. Coulter, with support from the Forces and Requirements Directorates.

COMMENTS AND QUESTIONS may be sent to the Director, US Army Concepts Analysis Agency, ATTN: CSCA-FO, 8210 Woodmont Avenue, Bethesda, Maryland 20814-2797.

ARMY STANDARD INFORMATION MANAGEMENT SYSTEM - EUROPE PHASE II TECHNICAL ARCHITECTURE

STUDY GIST

THE PRINCIPAL FINDINGS.

This effort developed an architecture for the automation sustainment mission in Europe which is based on (1) consolidation of applications based on functional or command lines, (2) connectivity between DPIs in a network based on traffic requirements, and (3) theater sustaining base automation management.

The study reached the following conclusions:

(1) The current ASIMS-Europe processing environment is being overrun with the requirements to add processing applications at each site.

(2) The current ASIMS-Europe architecture is inadequate to support the theater requirements. This includes: the timeliness of information due to the transfer of data between sites by courier, mail, and TCC; facility growth to accommodate larger processing requirement, personnel growth to support additional applications and facility growth; and the integration requirements to support the Community Automation objectives.

(3) The proposed ASIMS-Europe architecture, processing, and communications will support Theater requirements by: (a) upgrading existing hardware, software, and communications, (b) moving appropriate applications in accordance with the proposed architecture, and (c) integrating the DPIs into a network that provides connectivity between processing sites and entry points for USAREUR Community Automation System (UCAS) and other sustainment systems.

THE MAIN ASSUMPTIONS.

(1) Financial application estimates for processing load were within processor limits and fielding schedules remain constant.

(2) Network projections were built on a worst-case scenario which assumed that peak interactive use and file transfer occurred within the same operations shift. Furthermore, all anticipated users are accessing the network to remote nodes at the same time.

(3) Management of the sustainment infrastructure would be performed by the Operations and Maintenance (O&M) Command (5th Signal Command). Functional and Command management would occur through the Functional

Data Centers (FDCs) (i.e., 7th MEDCOM-Medical, TAMMC-Logistics, etc.) and USAREUR Major Command Data Centers (UDCs) (i.e., V Corps, VII Corps, SETAF, 21st TAACOM).

(4) Four sites were identified as Network Entry Points (NEPs) only. This is a reduction of the current mission which will scale the site to a low profile/low cost site.

THE PRINCIPAL LIMITATIONS.

(1) This study provides the major backbone between European DPIs based on functional and command requirements. Connecting additional users, LANS, and other hosts were not considered.

(2) Specific information regarding network usage by non-ASIMS applications and host interfaces was esitmated.

SCOPE OF THE STUDY.

(1) The scope of this effort encompassed the sustainment processing and communications requirements through 1992.

(2) The hardware under review consisted of the existing 14 ASIMS-Europe sites and two additional sites which also process sustainment applications (Rheinberg and Oberursel).

(3) The applications included Standard Army Management Information Systems (STAMIS), USAREUR standard systems, and local/functional uniques which process on the above hardware. Projected financial application estimates were also included.

(4) Tactical processors (i.e., DAS3, CTASC-I) and applications.

(5) Key interfaces into ASIMS were included for architectural consideration and transfer capabilities.

STUDY OBJECTIVES.

(1) To propose an architecture which optimizes the functions, applications, hardware, software, staffing, and sites for CINC USAREUR.

(2) To quantify per-site and per-application, all required hardware, executive software, environmentals, staffing, and communications.

(3) To specifically analyze the SIDPERS requirements for ASIMS-E since SIDPERS was initially targeted for all processing sites.

BASIC APPROACH.

In order to evaluate the projected sustaining requirements in Europe, specific details of current applications were collected and analyzed. This was accomplished by using the IBM System Management Facility (SMF)

accounting capabilities for CPU loads, DASD, Print, and interactive use by application and site. This information was loaded onto one system for query and modeling purposes. Summary information was extracted and further analyzed/modeled for the projected environment. Existing capital plant equipment was programmed for reutilization to reduce the projected acquisition requirements.

REASON FOR PERFORMING STUDY.

The study was performed to provide the sponsor with a System Engineered solution for the European sustainment requirements. This was prompted by the request to place several applications at every site (since there was no network service), saturation and poor response at several DPIs, and projected fielding schedules by some PMs that targeted the ASIMS-E DPIs as processing sites.

STUDY IMPACT.

(1) The study enabled the sponsor to provide USAREUR and HQDA with a sustainment architecture which is optimized for Functional and user services.

(2) The study also enabled the sponsor to recommend processing locations of the SIDPERS STAMIS and service capabilities under the proposed architecture.

STUDY SPONSOR.

Command General 5th Signal Command
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U. S. Army Information Systems Engineering Command (ISEC)
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Principals Authors: Kenneth Loudon, Larry Adamson, Sam Assi, Don Thiede

DTIC ACCESSION NUMBER: DA 307976

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START AND COMPLETION DATE OF STUDY:

December 1988 - October 1989.

THE PRINCIPAL FINDINGS

(1) The system consisting of 48 IRON candidate parts on 67 M1IP vehicles at the National Training Center (NTC) exhibited a consistent downward trend in reliability throughout the life of the vehicle. This decline in reliability is an indication of the existence of system degradation with age. In order to maintain better operational conditions on these aging vehicles, maintenance actions such as an inspection and repair program at depot should be considered for the M1 Abrams tanks.

(2) The optimal IRON induction period was estimated by considering both Operational Availability (Ao) and cost benefits by the IRON program. Based on system level economic analysis, a 5,500 mile period gives the best timing for IRON induction.

(3) In addition to the system level analysis for optimal IRON induction, an economic analysis was conducted to determine the optimal replacement time for individual components. The optimum replacement time for the M1 IRON candidate parts that have an increasing failure rate trend over the time period was calculated using the preventive maintenance model developed by Barlow and Hunter in 1960.

THE MAIN ASSUMPTION

(1) Tanks processed by the IRON program are assumed to be "good as new." This assumption implies that manhours and downtime characteristics would be the same as new vehicles.

(2) The downtime of a vehicle resulting from maintenance or any sort of delay was translated into a cost impact. In this study, it is assumed that if a vehicle is down due to failures and the unit can not maintain its readiness rate, then the unit would require an additional tank. The cost for an additional tank was estimated to be approximately $1,781 per day based on the M1 Baseline Cost Estimate (BCE).

THE PRINCIPAL LIMITATIONS

(1) As discussed under main assumptions

THE SCOPE OF THE STUDY

(1) Examines the results of aging trends on the reliability and maintainability of M1IP Abrams tanks.

(2) Investigates trends in system downtime and manhours as a result of component failures during the field training exercises.

(3) Develops the methodology used to calculate the optimum cycle for M1 IRON induction.

(4) Determine the point of economic repair or replacement for the M1 candidate parts.

(5) Identifies the benefits and impact of repairing under the IRON program as opposed to repair or replacement at the time of failure

THE STUDY OBJECTIVES

This study: (1) determines the optimal induction schedule for the IRON program based on the failure history of M1IP tanks stationed at the National Training Center (NTC), Ft. Irwin, California.

(2) identifies the optimal replacement time for the IRON candidate parts that have wearout characteristics.

BASIC APPROACH

The basic approach for this study was to determine the optimal inductio schedule for the IRON program. The data analyzed was replacement informatio for 48 IRON candidate parts collected from 19 Field Exercise Data Collection (FEDC) battalion field training exercises which occurred between 1986 throug July 1989. The 67 M1IP tanks used in the study accumulated 288,069 miles an averaged 4,300 miles per tank for the three year period. An optimal inducti schedule for the IRON program was determined by considering the system downt rate, the manhour repair rate, and cost estimates with and without the IRON program. In addition to the system level analyses for optimal IRON inductio an economic analysis was conducted to determine the optimal replacement time for individual components.

REASONS FOR PERFORMING STUDY

The M1 Inspect and Repair Only as Necessary (IRON) program is a limited depot inspect and repair program for M1 tanks returning from Europe for fielding to Continental United States (CONUS) units. This program is expected to save CONUS gaining units operating and support costs and downtim for repairs during field usage. The TACOM has asked AMSAA to determine the optimal induction schedule for the IRON program based on the failure history of M1IP tanks stationed at the NTC. Also, an economic model was required to develop in order to measure the impact of the IRON program on component repa and replacement.

STUDY IMPACT

The study suggest that IRON program should be considered for the aging M1 Abrams tanks. Based on economic analyses, the IRON program at a 5,500 mile period will be the best timing for the induction schedule since cost savings by IRON almost equal to an actual program cost.

STUDY SPONSOR

Commanding General
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START AND COMPLETION DATES OF STUDY:

Oct 89 - May 90

	ENGINEER STRUCTURE STUDY (ESS)	STUDY GIST

PRINCIPAL FINDINGS:

(1) The Division Engineer (DIVENG) force design alternative is superior to the base case (current) engineer force design and other alternatives examined. The DIVENG alternative includes an organic engineer battalion in each divisional maneuver brigade and a division engineer (Ø-6) with staff at division level.

(2) The DIVENG alternative results in eight to ten hours more time within the scenario examined to plan the counterattack, thereby permitting better execution of three of the four tenets of AirLand Battle doctrine.

(3) The DIVENG alternative better executes the countermobility missions by emplacing three times the number of obstacle zones which disrupts the threat tempo in the corps battle.

(4) Close battle losses decrease nine to twelve percent in the DIVENG alternative, indicating that improved C2 execution provides a measure of greater effectiveness/survivability for the corps maneuver forces.

(5) The DIVENG alternative provides an increase in lethality as seen in a three percent increase in Red ACV losses.

(6) The DIVENG alternative more effectively accomplishes the critical task of transitioning from offense to defense.

(7) A command and control (C2) performance model (Modeler) was successfully linked to a force-on-force combat simulation [Corps Battle Analyzer (CORBAN)] to measure the force effectiveness of C2 alternatives.

MAIN ASSUMPTIONS:

(1) AirLand Battle doctrine, as described in FM 100-5, will remain valid through 1996.

(2) Systems in development will be available and will meet their performance requirements and design characteristics.

(3) All alternative engineer force structures must exhibit zero personnel growth from the Total Army Analysis fiscal year 1996 (TAA96) programmed strength.

(4) Use of military judgement by subject-matter experts (SMEs) is appropriate when analytical or field data is not available.

PRINCIPAL LIMITATIONS:

(1) The study evaluated alternative engineer structures in only one scenario (Europe), one time frame (1996), and one mix of equipment.

(2) Data to drive the C2 performance modeling was derived from SMEs placed in an operational context, not from field exercises.

(3) The study examined only the heavy force.

SCOPE OF THE STUDY:

(1) The study examined the capabilities of the programmed TAA96 engineer force structure (base case) and three conceptual alternative force structures.

(2) The study examined the base case and alternative force structures from both C2 performance and force effectiveness perspectives.

(3) The study addressed engineer forces in Europe supporting heavy forces from a corps perspective.

STUDY OBJECTIVES:

(1) Determine the preferred engineer force structure to support a maneuver (armor) corps on the AirLand battlefield.

(2) Identify issues associated with the preferred force structure that may require further independent evaluation.

(3) Develop and execute a methodology which evaluates engineer maneuver C2 alternatives in terms of force (corps) effectiveness.

BASIC APPROACH: The basic approach for this study was to develop a wide range of engineer force structure alternatives, evaluate each in terms of C2 performance and resulting force effectiveness at the corps level. Modeler was used for C2 performance. Resulting C2 performance measures (mostly time delays) were input to CORBAN for force effectiveness analysis measures. Resulting measures of effectiveness were used to make recommendations regarding the engineer force structure alternatives.

REASONS FOR PERFORMING STUDY: The engineer support to a heavy division has long been thought to be unresponsive and inadequate. Engineers, who must support the battle at the point of execution, have not been able to keep pace with an expanding battlefield with the same force structure used in World War II. The Commander, TRADOC, and the Army Chief of Staff tasked the U.S. Army Engineer School to conduct this study with analysis support from the TRADOC Analysis Command.

STUDY IMPACT: This study was responsible in part for the Army Chief of Staff decision to implement the DIVENG alternative force structure in Europe and Korea. World-wide implementation is under consideration.

STUDY SPONSOR:

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START AND COMPLETION DATES OF STUDY:

May 1989 - May 1990

MRSA

GIST

STUDY TITLE: Just-In-Time (JIT) Inventory Practices

PRINCIPAL FINDINGS: Just-In-Time inventory is a viable concept for Army use, but adoption of JIT strictly as private industry uses it is not feasible because of fundamental differences in mission, restrictions, resources, and risks. The basic concepts of reduced stock levels for selected items and constantly improving quality can be used to improve Army logistics.

MAIN ASSUMPTIONS: This study assumes that if JIT practices are in some way adopted by AMC, current Army logistical practices would still be in effect.

PRINCIPAL LIMITATIONS: This study is limited to a discussion of JIT principles and practices and corresponding Army principles and practices; it does not include economic analysis, nor does it propose any specific type of JIT test within AMC.

SCOPE OF THE EFFORT: The scope of this study is limited primarily to possible applications of JIT within the U.S. Army Materiel Command.

OBJECTIVES: The objectives of this study are to review JIT practices in private industry, discuss the possible uses of JIT practices within Army logistics, discuss the benefits and disadvantages of JIT to the Army, and to nominate sample items for possible use in a future test of JIT principles within AMC.

BASIC APPROACH: The basis of this study was the review of a collection of books and periodical articles elicited from an extensive literature search at the Library of Congress, the Pentagon Library, the HQ, AMC, and two libraries at the University of Kentucky. Visits were made to private industries, an Army ammunition assembly plant, two Army depots, an Air Force base, and three AMC major subordinate commands.

REASON FOR PERFORMING THE STUDY OR ANALYSIS: This study was requested by HQ, AMC, (AMCSM-MSR) to review the possibility of applying JIT to Army logistics to improve quality and efficiency and to reduce costs.

IMPACT OF THE STUDY: The areas within Army logistics that are impacted by this study are procurement and supplier relations, inventory management, requirements determination, risks, flexibility, transportation, and quality.

SPONSOR: Mr. Nelson Martin (HQ, AMC).

PRINCIPAL INVESTIGATOR: Ms. Nancy Morris (USAMC MRSA).

MRSA
STUDY TITLE: Just-In-Time (JIT) Inventory Practices

NAME, ADDRESS, AND TELEPHONE NUMBER WHERE COMMENTS AND QUESTIONS CAN BE SENT:

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DTIC/DLSIE ACCESSION NUMBER OF FINAL REPORT: Not assigned at this time.

PRINCIPAL FINDINGS:

- Combined Forces Command (CFC) should continue a vigorous program to maintain and upgrade the Korea Barrier System (KBS).
- CFC should give increased consideration to obstacles that can be quickly executed. The obstacle system must hinder the threat forces while at the same time ensuring freedom of movement for friendly forces.
- CFC should improve the barrier plan further by using more complex obstacles and revising the density of new and planned minefields.
- CFC should exploit north Korean Army (nKA) weaknesses by employing battlefield deception, and extending the battle with long-range fires to the nKA lines of communication (LOC), including use of family of scatterable mines (FASCAM).
- CFC should use the KBS database as a tool to plan and monitor the progress of the upgrade program developed as a result of this study. However, before the database can be used in this way, the consistency and coverage of the database must be improved.

MAIN ASSUMPTIONS:

- The KBS database, which includes guidance from CFC on the latest revisions to the data as of 15 Dec 88, accurately characterizes CFC's obstacle system in numbers, type, age, and description of obstacles.
- All planned and partially completed obstacles are successfully executed in a timely manner according to plans.
- Winter cross-country mobility (CCM) rates are assumed.

PRINCIPAL LIMITATION: The study is based primarily on available intelligence estimates of current nKA counterbarrier capabilities. The study also uses Ground Order of Battle (GOB) and force disposition intelligence for the nKA.

SCOPE OF THE STUDY: The study examines the density and mix of the system of obstacles emplaced to block an attack across the demilitarized zone (DMZ).

- The existing barrier system and various barrier alternatives are evaluated to assess how well they support current CFC forces and Operations Plans (OPLAN).
- The study looks at ways to improve the effectiveness of the present barrier system, considering variations in the density and mix of current components of CFC's barrier system.
- The study considers new technology systems only if they were expected to be in production before 1995.

STUDY OBJECTIVE: To present the results of an evaluation of the adequacy of the KBS supporting OPLAN 5027; and to identify serious deficiencies that exist in the current plan which cast doubt on its overall effectiveness. The study recommends actions CFC should take to significantly improve the obstacle plan.

BASIC APPROACH: The key elements of the study approach are described below:

- **Publication of *The Strategic Performance of Defensive Barriers*.** This report discussed the strategic performance of 20th Century barrier systems and identified important criteria useful in comparing CFC's barrier system with other barrier and fortification systems.

- **Publication of *The north Korean Counterbarrier Threat*.** This separately published monograph analyzed the tactics that the nKA may employ to breach components of CFC's obstacle system.
- **nKA and Republic of Korea Army (ROKA) Force Ratio Computations.** In this portion of the study ESC reviewed numerous intelligence reports to establish the size and makeup of nKA units along each attack corridor.
- **Data Review.** During the database review, ESC created and analyzed reports from the March, 1988 version of the KBS database received from CFC.
- **Obstacle System Analysis.** This part of the study included the analysis of the density and mixture of obstacle components for all divisions in the GOP, forward edge of the battle area (FEBA) A and FEBA B phaselines.
- **COSAGE Analysis.** The simulation model, COSAGE, was used to evaluate battle outcome in the following situations: with no barriers (reference cases); with representations of CFC's current obstacle plan (base cases); and representations of additional barriers (alternative cases).
- **Descriptions of Current and Future Obstacle Systems.** Descriptions and diagrams of various components that make up the KBS are presented in the study (Annex F). Also included are discussions of future obstacle systems that are anticipated to be in production by 1995.

REASONS FOR PERFORMING THE STUDY: In 1982, ESC performed two studies for CFC: *An Evaluation of the Adequacy of the Obstacle Plan Supporting OPLAN 5027* and the *FASCAM Employment Potential for the Combined Forces Command*. These two studies analyzed the CFC engineer forces ability to support the existing barrier system. Since that time, changes in the CFC OPLAN, changes in nK forces, the age of some barrier components, and advances in barrier technology led CFC to ask ESC to do this study.

STUDY SPONSOR: The sponsor of the study was the Combined Forces Command Engineer.

PERFORMING ORGANIZATION AND PRINCIPAL AUTHORS: This study effort was performed by ESC under the direction of Mr. Stephen C. Reynolds. The principal authors were CPT (P) Dale M. Bleckman, Mr. Otha W. Evans, Mr. Robert H. Halayko, Mr. Reuben E. Harris, Jr., Dr. Lawrence C. Smith, Mrs. Dinetha L. Thompson, and Mr. Fredrik W. Wiant.

DTIC ACCESSION NUMBER OF FINAL REPORT: C957-261L

COMMENTS AND SUGGESTIONS MAY BE SENT TO: Director/Technical Director, U.S. Army Engineer Studies Center, Casey Building #2594, Ft Belvoir, VA 22060-5583.

START AND COMPLETION DATES OF STUDY: Starting Date: July 1987
Completion Date: February 1990

	Longbow Cost & Operational Effectiveness Analysis (U)	**Study Gist**

The Reason for Conducting the Study was to provide a cost and operational effectiveness analysis of the Longbow on the AH-64 Apache helicopter and recommend a preferred alternative in support of a Longbow Milestone II 1990 ASARC decision to enter into full scale engineering development.

The Principal Results. Attack helicopters play a major role in the Army's ability to meet threat, environmental, and technological challenges of the future. When all alternatives were compared to the base case, AH-64 Longbow was the preferred alternative to meet the mission needs of the ATKHB in the heavy division and corps. This conclusion is supported by the findings of both the Apache Procurement Strategy Analysis and the LH COEA.

The Major Restrictions of the study were:

- that only three scenarios were used to generate the threat
- only one simulation model was used to play the scenarios and
- the mixing of SAL-Hellfire and RF-Hellfire missiles on an individual aircraft on the same mission was not analyzed.

The Scope of the Study. The analysis examined the missions, capabilities, operational concepts, and operational effectiveness of the Longbow system and alternatives, considering logistical, training, MANPRINT, and cost implications. The three alternative configurations, the AH-64A, AH-64 PIP, and AH-64 Longbow were compared in the operational environment of Europe and Southwest Asia in a 1996 Blue and 2004 threat timeframe.

The Study Objective was to determine the preferred Apache alternative, the AH-64A, AH-64 PIP, or the AH-64 Longbow, to fulfill the needs of the ATKHB in the heavy division and corps.

The Basic Approach. The approach consisted of several steps leading to recommendation of a preferred alternative. The first steps were to assess the threat, identify the missions and tasks required of the ATKHB, and identify the resulting battlefield deficiencies of the ATKHB. The next step was to examine current and programmed capabilities and opportunities to correct the battlefield deficiencies; and to recommend alternatives for further evaluation. The final steps

were to examine and compare the alternatives in the areas of characteristics and performance, SEOP, effectiveness, logistics, training, MANPRINT, and costs.

The Study Sponsor was HQ DA, ATTN: SARD-TN, Washington, DC 20310-0103

The Study Agency was the U.S. Army TRADOC Analysis Command-White Sands Missile Range, Close Combat Directorate, ATRC-WA, White Sands Missile Range, New Mexico 88002-5502. Point of contact is Roger C. LeDoux, AUTOVON 258-4300.

The Study Impact. If an appropriate Apache alternative is not selected, programmed funds will be made available for less cost effective competing armor-anti-armor systems which will not be capable of improving force effectiveness nearly as well as Apache Longbow.

CAA	NATO 2000 (U)	STUDY SUMMARY CAA-MR-90-20

THE REASON FOR CONDUCTING NATO 2000 was to examine the conditions to which NATO will be subjected over the next decade and derive a well-reasoned assessment of its future.

THE OBJECTIVES OF THE STUDY were to:

(1) Identify likely European scenarios for the year 2000.

(2) Identify events and characteristics of these scenarios.

(3) Identify important factors that should affect Army planning.

THE BASIC APPROACH followed in the study was to:

(1) Select issues that would impact on the Army's future in NATO.

(2) Collect data from experts on each of the issues.

(3) Use the data to produce forecasts from a political forecasting model.

(4) Reinterview experts to collect their critique of the results and record their predictions.

(5) Collate forecasts and predictions to identify likely scenarios.

THE PRINCIPAL FORECASTS are:

(1) By 1993-1995, 70,000 to 135,000 US troops (US Army, US Air Force, US Navy) will be stationed in Europe. By 2000, this number will be 50,000 to 70,000.

(2) Between 1995 and 2000, all US tactical nuclear weapons will be removed from Europe except for air-delivered munitions stored in England.

(3) Annual NATO infrastructure spending will decline from $2 billion to $1.6 billion in the next few years. By 2000, annual spending levels could decrease to $1 billion.

(4) Germany will remain a member of NATO throughout the decade.

(5) While the ability of the Warsaw Treaty Organization to conduct coalition warfare has ceased, it will loosely function as a political forum throughout the decade. The Soviet Union, Bulgaria, Romania, and possibly Poland will be members.

(6) Soviet troops will be withdrawn from East Germany by 1996-1997.

(7) The European community will achieve a single market in the early 1990s. Monetary union will not occur this decade.

(8) NATO will continue to provide stability to Europe during Eastern Europe's transition from Soviet domination to independent national identities.

(9) After this transition, NATO will most likely become a Western caucus within the Conference on Security and Cooperation in Europe (CSCE), the future forum for European security relations. At the same time, Western Europe, through the European Community organization, will emerge on equal footing with the US and the USSR.

THE STUDY SPONSOR was Headquarters, Department of the Army (HQDA), Office of the Deputy Chief of Staff for Operations and Plans (ODCSOPS), ATTN: DAMO-SSP.

THE STUDY EFFORT was conducted by CPT Eric E. Stebbins, Strategy and Plans Directorate, US Army Concepts Analysis Agency (CAA).

COMMENTS AND QUESTIONS may be sent to the Director, US Army Concepts Analysis Agency, ATTN: CSCA-SPC, 8120 Woodmont Avenue, Bethesda, MD 20814-2797.

CAA	RATES OF ADVANCE IN HISTORICAL LAND COMBAT OPERATIONS	STUDY SUMMARY CAA-RP-90-1

THE REASON FOR PERFORMING THIS STUDY was that original analyses of the statistical data on rates of advance are called for. Past analyses have used more limited data bases and often a narrower set of alternative hypotheses. We are not aware of any other work that covers this area as thoroughly as this Research Paper does.

THE STUDY SPONSOR was the Secretary of the Army. This is the third and last paper to be prepared by Dr. Robert L. Helmbold under his Secretary of the Army Research and Study Fellowship.

THE STUDY OBJECTIVE was to provide the Army with original analyses of the available data on rates of advance, using a larger set of data than has been used in the past, and a range of alternative hypotheses. As such, it furnishes a valuable resource for further work in this important field.

THE SCOPE OF THE STUDY was intended to be broad, in the sense of using all of the available data to examine a wide range of worthy hypotheses. No doubt it is too much to hope that the paper used literally all of the available data or included all of the important hypotheses. Nevertheless, its analyses should be very helpful to military historians and operations researchers.

THE MAIN ASSUMPTION of this paper is that no data or hypothesis that would substantially alter its principal findings has been overlooked.

THE BASIC APPROACHES used in this study were to:

a. Obtain through extensive personal visits, correspondence, and phone calls all of the noteworthy documents with statistical data on rates of advance,

b. Compile, computerize, describe, critique, and comparatively review them, and then to

c. Use these data to examine a wide range of alternative hypotheses about rates of advance.

THE PRINCIPAL FINDINGS of the work reported herein are:

a. A lot of statistical data on rates of advance in land combat operations is available, but for a given purpose only a properly chosen part of it is useful. Sometimes none of it applies.

b. Past work used a variety of subjective descriptors and *ad hoc* terminology. This subjectivity and lack of standardization makes systematic comparisons difficult, and sometimes impossible.

c. Several sources, some intentionally and others unintentionally, tended to select cases of a successful advance by the attacker. This biases the data against successful defensive efforts and in favor of advances by attackers.

d. Reported advance rates tend to be systematically biased toward lower values than are actually achieved. This bias can cause reported rates to be too low by factors around 3 to 5, and seriously distorts the apparent influence of size upon rate of advance.

e. Several epistemological weaknesses affect past work. Among the more important are:

(1) Inadequately caveating hasty and premature overgeneralizations based on only a small number of cases, or on a narrow sample of cases representing only a particular time and operational context.

(2) Theory and observation are seldom compared directly, quantitatively, and in detail.

(3) Despite their effectiveness in other contexts, advanced multivariate statistical methods have been singularly unsuccessful and often misused when dealing with advance rates.

f. Reported advance rates do not seem to have changed much over the last 400 years or so. But the data are widely scattered and highly variable.

g. Reported advance rates may be somewhat higher for battalion-sized units than for larger ones. But the data are widely scattered and highly variable.

h. For heavily engaged forces, reported advance rates of mechanized and armored units are about the same as for infantry units. But for lightly engaged forces reported advance rates of mechanized and armored units are somewhat higher than for infantry units. But again the data are widely scattered and highly variable.

i. Reported advance rates for lightly engaged forces are substantially higher than for heavily engaged forces. However, the evidence indicates that both lightly and heavily engaged forces stand still about 90 to 99 percent of the time. This observation suggests that the key to understanding advances by land combat forces may lie not with their periods of movement, but instead with their periods of standing still. As in other cases, the data are widely scattered and highly variable.

j. Reported advance rates are somewhat higher in summer than in winter—more so for mechanized and armored units than for infantry, but the data are widely scattered and highly variable.

k. Reported advance rates are not consistently lower for longer operations. In fact, on the average, extended operational advances proceed at a steady uniform pace. But the data are widely scattered and highly variable.

l. Reported advance rates are not normally distributed. They are highly skewed and follow a lognormal distribution much more closely than they do either a normal, exponential, Weibull, or gamma distribution.

m. Reported advance rates are practically independent of force ratios. They are much more strongly associated with other indexes of combat capability. But the data are widely scattered and highly variable.

n. Both our and past efforts to devise consistently accurate schemes for predicting advance rates have been unsuccessful. Accordingly, the hypothesis that advance rates are governed primarily by chance should receive serious consideration in future work. Also, the nonmovement phases should be studied in conjunction with the movement phases of land combat operations.

THE STUDY EFFORT was directed by Dr. Robert L. Helmbold, Office, Special Assistant for Model Validation.

COMMENTS AND SUGGESTIONS may be sent to the Director, US Army Concepts Analysis Agency, ATTN: CSCA-MV, 8120 Woodmont Avenue, Bethesda, Maryland, 20814-2797.

ABSTRACTS FROM THE DR. WILBUR B. PAYNE MEMORIAL

AWARD FOR EXCELLENCE IN ANALYSIS 1990

The Dr. Wilbur B. Payne Memorial Award
for
Excellence in Analysis
1990

The award for the best multiple authors paper in Army systems analysis/operations analysis went to Messrs. Roy F. Reynolds and Richard R. Laferriere, and LTC Roger C. LeDoux, all of US Army TRADOC Analysis Command-WSMR, and CPT Peter M. Vozzo, US Army Aviation Center. Their paper, *Apache Procurement Strategy Analysis*, TRAC-WSMR-TR-90-012, May 1990, is classified SECRET.

The Apache analysis used combat simulation output to assess the durability, force contribution, and cost effectiveness of 11 alternative aircraft fleet mixes. The analysts selected five criteria to examine the benefits and burdens associated with ownership of a fleet.

System effectiveness, the first criterion, refers to the potential kills of a given fleet based on fleet size, missions, and survivability. Kills and survivability values were drawn from results of high resolution simulations. System exchange ratios (SERs) were obtained for each mission. The number of kills for the fleet was computed from the SERs for each mission.

Battle capacity, or number of battles a fleet can conduct across a range of missions, is the second criterion. The requirement was for any alternative fleet mix to be capable of engaging in as many battles as the base case fleet.

Systems saved, the third criterion, relates to the level of protection provided by helicopters in alternative fleet mixes if fought to the same number of battles as the base case. High technology systems have potential for more favorable results by using few systems to conduct battles and by enhancing survivability of other direct fire systems in the force.

Force effectiveness, the fourth criterion, refers to kills expected from the force, including all direct fire systems, if an alternative mix is fought to the same number of battles as the base case. This criterion considers particular system's direct contribution to force effectiveness and the synergistic effect on other combat systems.

The last criterion, **cost effectiveness**, integrates costs of development, acquisition and operation of each mix alternative, and each alternative's effectiveness. Effectiveness refers to force kills (force effectiveness) **and** system kills (system effectiveness).

The innovative approach of the authors is a valuable

The innovative approach of the authors is a valuable demonstration of the contribution of combat model output to assessment of force durability and force effectiveness.

The approach has application beyond those used in the Apache procurement strategy analysis. It can be used with a variety of combat simulations and weapons types. Fruitful situations include meeting engagements, counterattacks, strongpoint defense, and multiple battlefield environments across the regional spectrum. Equal cost or equal effectiveness bases can be used; a variable cost, variable effectiveness approach was used in the Apache case. A system of interest can be assessed annually from research and development to fielding and throughout the life of the system. The implementation of the method will continue to provide useful information to support DA and DOD decisions in the materiel acquisition process.

The award for the best individual author paper in Army systems analysis/operations analysis went to Mr. David Chung, US Army Materiel Systems Analysis Activity. His paper is titled *M1 Inspect and Repair Only As Necessary (IRON) Study*,

The IRON program is a maintenance concept for depot level inspection and repair of, in this case, aging M1 tanks. To evaluate the concept, the US Army Tank-Automotive Command (TACOM) was directed by Headquarters, Department of the Army to conduct a pilot test project on one battalion of tanks being returned to the US from Europe. Fourteen tanks from the battalion were put through Anniston Army Depot under the IRON concept. Following the procedure at Anniston, the 14 tanks were sent to the National Training Center (NTC) with the balance of the battalion's tanks (46) for a comparison of the IRON program with the normal maintenance program in reducing maintenance and increasing reliability. [The test was scheduled to be run from May to September 1990; results are not available for this abstract.]

To support the project, US Army Materiel Systems Analysis Activity was asked by TACOM to develop models to evaluate the potential costs and benefits of the IRON program and predict optimal times for component and system level repair. Mr. Chung's approach to the analysis was designed around three facets:

- Analysis of M1 system level trends in maintenance, reliability and support costs as a function of age; this facet would provide the basic premise supporting the IRON program;

- Development of an economic model to determine optimal induction mileage for the IRON program; and

- Development of a predictive model to determine optimal removal and repair time for individual M1 components.

For the trend analysis (first facet), Mr. Chung used high mileage data for M1 tanks over a four-year period at the NTC. He used regression techniques to express the trends as a function of mileage (representing age). The trends were used in a system level cost model developed by Mr. Chung to determine optimal mileage for IRON induction. For different mileage intervals, the model compared the cost of the IRON program at the depot with the return on investment in terms of reduced maintenance and support costs. [When the NTC test data on IRON vehicles are provided, the model will be used to evaluate cost-effectiveness of the IRON program and the optimal induction mileage. The results will provide the basis for Army decisions on continuation of the IRON program.]

Mr. Chung also developed a model to determine optimal replacement time for individual components. Mr. Chung determined

the failure distribution for components to evaluate survival probabilities at different mileage intervals. For components with wear out characteristics, he developed cost functions giving cost of maintenance as a function of preventive maintenance periods. The results will be used in planning IRON procedures to identify components as candidates for replacement or repair.

In carrying out these analyses, Mr. Chung produced results which were technically sound, well organized, and responsive to the needs of Army planners and programers. Documentation and briefings have been clear and well-prepared. Mr. Chung's analyses will play an important role in evaluating costs and benefits of the IRON program and providing analytical support for decisions concerning continuation and expansion of the program. His work deserves to be recognized for its originality, quality, and technical merit.